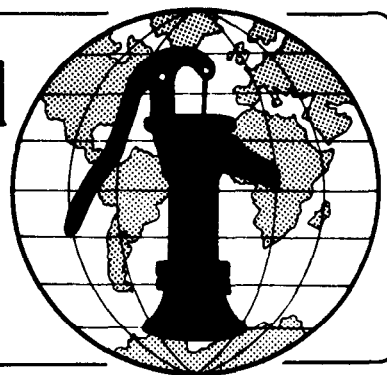


Water for the World

Operating and Maintaining a Biogas System Technical Note No. SAN. 3.O.4



A biogas system is a means of digesting animal manure anaerobically to produce methane gas which is burned to provide heat or light. The system consists of one or more digesters, a gas holder, an arrangement of gas pipes, and one or more fixtures to burn the gas. Operating and maintaining a biogas system requires the services of a foreman experienced with these systems. Operating involves preparing the gas holder, filling the digester, testing for methane gas production, using the gas, and emptying and refilling the digesters every one to three months. Maintaining involves checking for gas or water leaks and repairing them at once.

This technical note describes how to operate and maintain a biogas system. Read the entire technical note before beginning operation.

Useful Definition

METHANE - A gas produced when organic material such as manure decomposes in an airless environment; methane burns with a violet flame without smoke; it is explosive.

Materials Needed

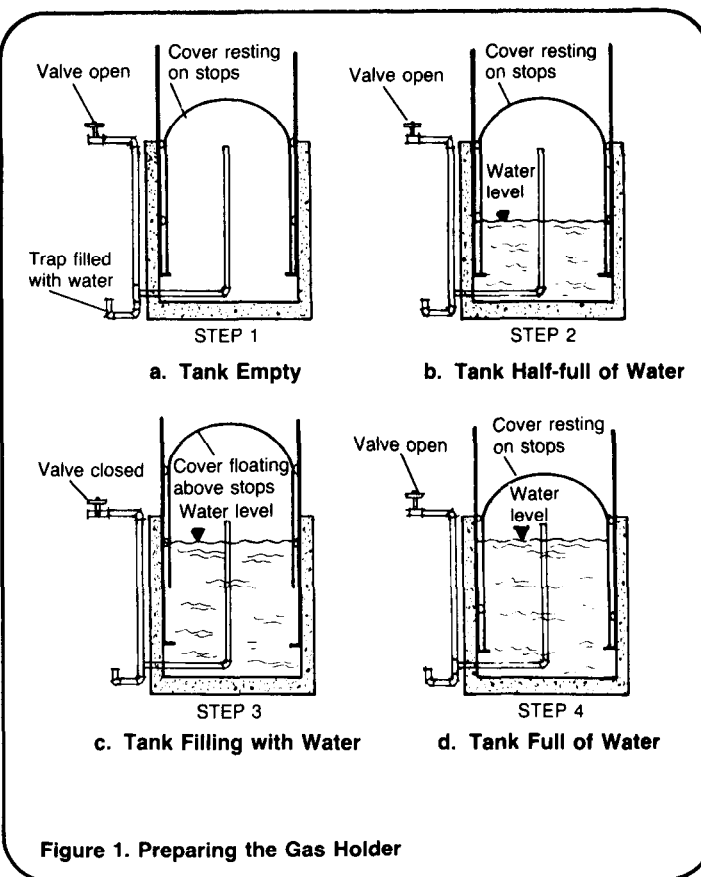
For operating: shovels, rakes, scoops, buckets, ropes, containers, carts, gloves, boots.

For maintaining: concrete mortar mix, gas pipe, pipe installer's tools, wrenches, threader, pipe joint compound, method for leak detection, replacement valves, and petcocks.

Preparing the Gas Holder

1. Fill the water trap with clean water to make it gas-tight. This arrangement prevents condensation in the pipes from blocking the pipes and allows it to flow out of the system. See Figure 1a.

2. Close all valves and petcocks in the system. Open the valve leading to the first digester to be put into use. Remove the digester's manhole cover.



3. Fill the gas holder half-full with clean water. The floating cover should remain at its lowest position, resting on the stops on the guideposts, because as water fills the cover, the air inside is forced out through the gas pipe and through the open valve. See Figure 1b.

4. Close the valve.

5. Fill the gas holder nearly full with clean water. The floating cover should rise on its guideposts. Because the air inside is trapped, it cannot be forced through the gas pipes. See Figure 1c. Check that the cover rises smoothly and evenly within the posts. If it does not, make necessary repairs before proceeding. This may require removing the water.

6. Open the valve. The floating cover should sink to its lowest position, forcing the air out through the pipes and the open valve. See Figure 1d.

7. Close the valve.

Filling the Digester

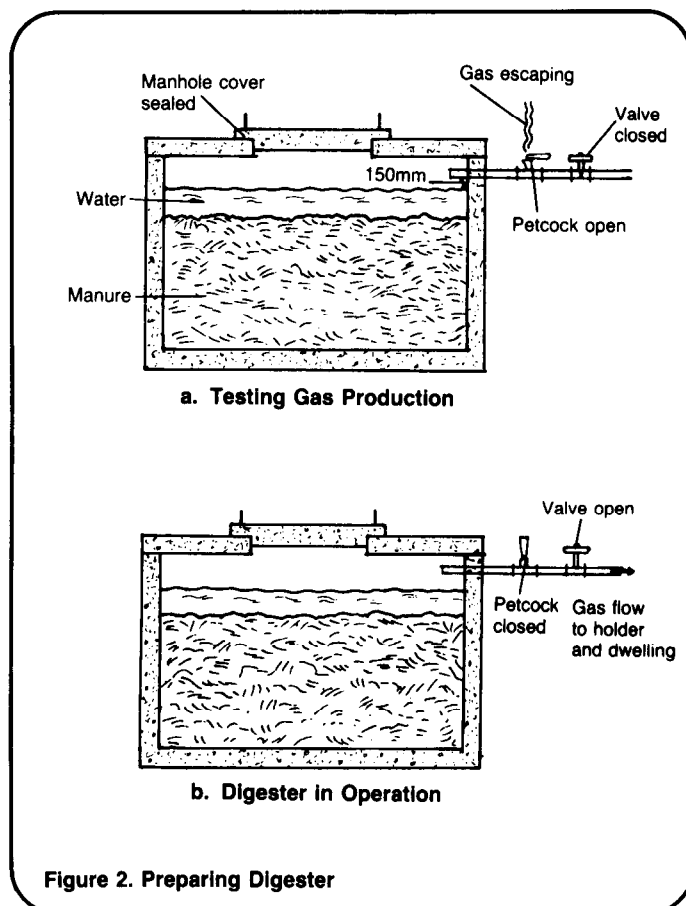
1. Store manure in stacks until ready for use. Turn the stacks every few days for one or two weeks. This will allow the material to partially decompose, reducing acid-forming substances and resulting in better gas production.

2. Fill the digester one-half to two-thirds full with partially-decomposed manure. Leave the manhole cover off and allow air into the digester for three days. This will further prepare the manure for gas production.

3. Fill the digester with water to within about 150mm of the gas pipe. Set the manhole in place and seal it with tar or equivalent to make it gas-tight. See Figure 2a.

Testing for Gas Production

1. After the digester has been sealed, open the petcock and leave it open for two or three days. This will



allow gases to escape which are produced in the early stages of decomposition and which do not readily burn. See Figure 2a.

2. After a few days, open the petcock and attempt to ignite the gas being emitted. If it will not light, close the petcock.

3. Attempt to light the gas every day, closing the petcock after each attempt. It will take one or two weeks before the digester begins producing satisfactory gas. When the gas escaping from the open petcock can be ignited and will burn with a continuous flame, it is ready for use. Close the petcock and open the valve. See Figure 2b.

4. If methane gas production continues to fail after a month, it is probably because of acidic conditions in the digester. Do one or more of the following: (a) add lime or ammonium phosphate in a starting dose of 10 liters per m^3 of digester contents and mix well; (b) add more horse or cattle

manure as these are alkaline; (c) add material from a digester that is already working well to help start the new digester.

Using the Gas

1. Methane gas will fill the gas lines and begin to fill the floating cover, making it rise.
2. Open the valve in the dwelling and allow gas to reach the user's fixtures. Each fixture must have its own shut-off valve which must be kept closed until ready for use. See Figure 3.
3. The digester will continuously produce gas for one to three months, depending on the temperature and the exact contents of the tank. When a fixture is in use, gas will flow from the digester to the fixture. When the fixture is not in use, gas will flow from the digester to the gas holder. When gas production slows, for example, at night when it is cooler, and the fixture is used, gas will flow from the gas holder to the fixture.

Caution!

Certain mixtures of air and methane gas are explosive. Do not smoke, cause sparks, or carelessly light matches near the system. Be especially careful when a digester is being opened. There is risk of an explosion at the surface and later in the digester as oxygen-rich air enters.

Emptying and Refilling the Digesters

The contents of the digester will produce methane for a certain period of time, generally one to three months. The production will be low at the beginning of the time period, gradually rise to its highest rate near the middle of the time period, and decline to a low rate near the end. To maintain a relatively steady rate of gas production, alternate the use of the digesters. That is, when the first digester nears its peak of production, start up the second digester. When the second digester nears its peak, it will

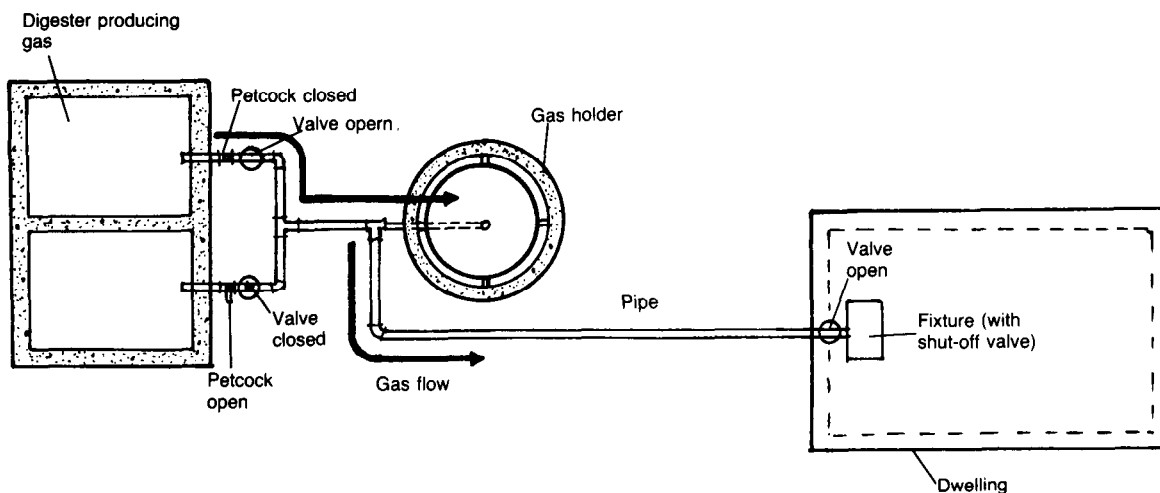


Figure 3. Biogas System in Operation

be time to empty the first digester and refill it with a fresh load. This alternating process must continue as long as gas is wanted. The length of the time period from start up to peak rate to emptying depends on digester capacity, digester load, manure quality, temperature and bio-chemical actions. With experience in the field, the best combinations and results will be learned.

1. When it is time to empty a digester, close the valve and open the petcock. Leave the petcock open for a few days to allow methane to escape from the digester.

2. Remove the manhole cover and allow the digester to air out for a few days.

Maintaining the System

Routinely check for gas leaks. Methane leaking from gas pipes, digesters, or the gas holder will have a barnyard odor. If a leak is detected, it should be repaired at once. Leaks in the digester or walls of the gas holder can be repaired with concrete mortar. Leaks in the pipes may be repaired by tightening fittings or replacing sections of pipe. The system may have to be shut down to make repairs. In any case, repairs must be made by experienced personnel.

Caution!

Gases present in the digester and the absence of oxygen can cause a worker to be overcome quickly and die. Never work around an open digester without a safety rope and strong workers standing by.

3. Remove most of the decomposed contents of the digester with scoops, buckets and ropes, shovels, or other means. See Figure 4. Leave about 100mm of solids and about half of the liquid material in the digester to enhance gas production in the next load.

4. Haul the removed contents in containers and carts to crop land. Spread it on the ground and work it into the soil. It is an excellent fertilizer since it is high in nitrogen compounds. See Figure 5.

Although all pathogenic organisms are killed by digestion, always wear boots and gloves when handling the contents of the digesters as an added precaution. If digestion is incomplete, round worm eggs may be present.

5. Reload the digester. See "Filling the Digester." Methane production will probably begin sooner than before. The old contents remaining in the digester seed the new manure.

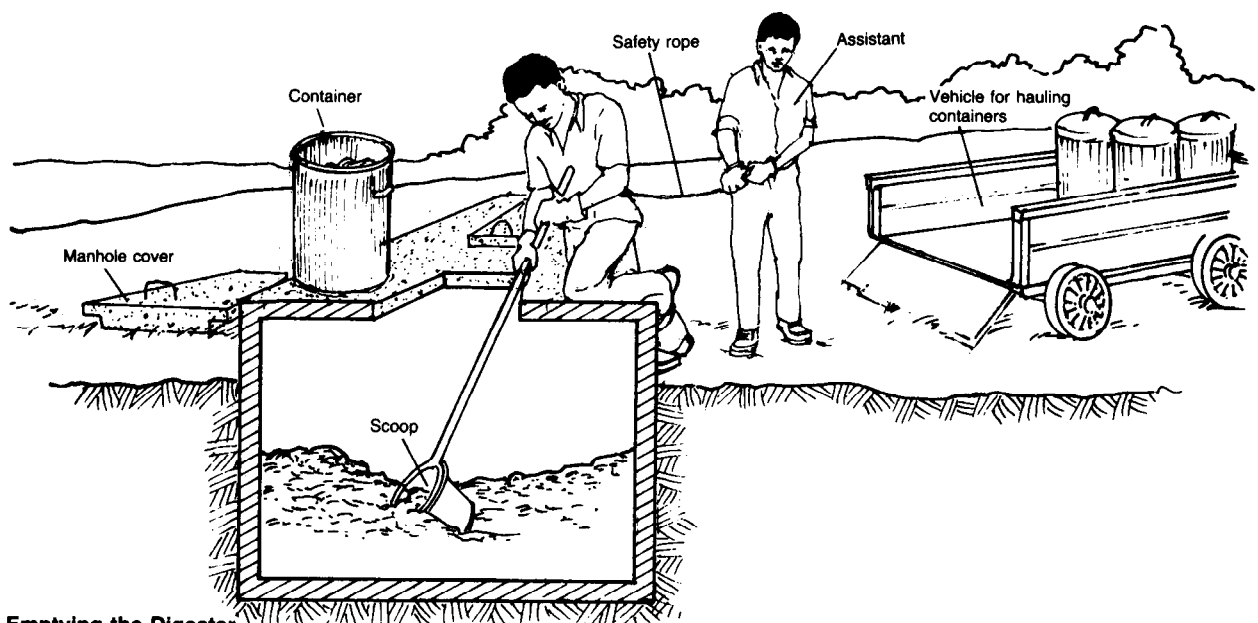


Figure 4. Emptying the Digester

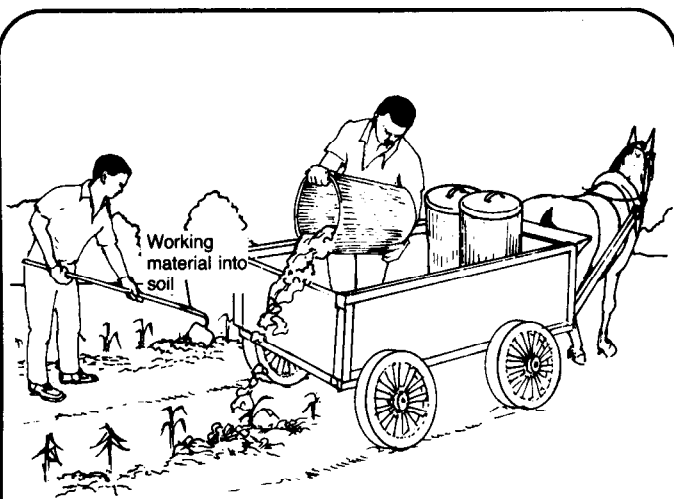


Figure 5. Disposing of Decomposed Contents of Digester

Check for water leaks in the gas holder. The water level will fluctuate as the floating cover lifts and sinks, and there will be a slight loss of water after the holder is first filled as the walls cure. A continual loss of water indicates a leak. Locate the leak and repair it with concrete mortar. This may involve excavating around the gas holder.

Maintain a record similar to Table 1 showing all operation and maintenance activities.

Table 1. Sample Operation Record for a Biogas System

Date	Task
5/1	Stacked manure.
5/5	Turned stacks.
5/9	Turned stacks. Closed valve and opened petcock on Digester #1.
5/11	Removed manhole cover on Digester #1.
5/13	Emptied digester except for small amount. Spread contents in field.
5/14	Loaded the digester with manure.
5/16	Add water to digester; sealed manhole cover; checked that valve was closed and petcock open.
5/18	Checked gas for ignition. No. Closed petcock.
5/19	" " " " " " "
5/20	" " " " " " "
5/21	" " " " " " "
5/22	" " " " " " "
5/23	" " " " " " "
5/24	Checked gas for ignition. Yes. Closed petcock and opened valve.